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(54) **ORAL COMPOSITION**

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See application file for complete search history.

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(57) **ABSTRACT**

The present invention provides an oral composition comprising hydroxyapatite, potassium nitrate, and calcium monohydrogen phosphate, wherein the composition has an increased ability to occlude dentinal tubules of a tooth and has an excellent inhibitory effect on hypersensitivity.

1 Claim, 8 Drawing Sheets

Figure 1

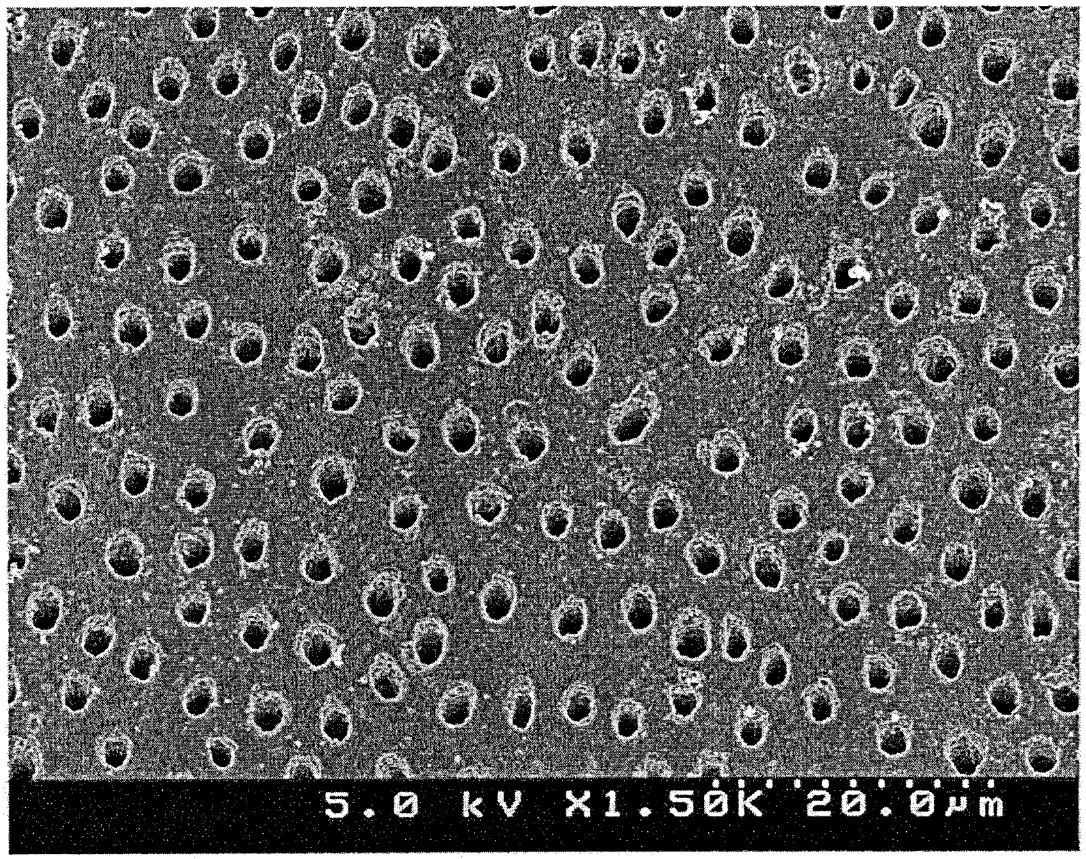


Figure 2

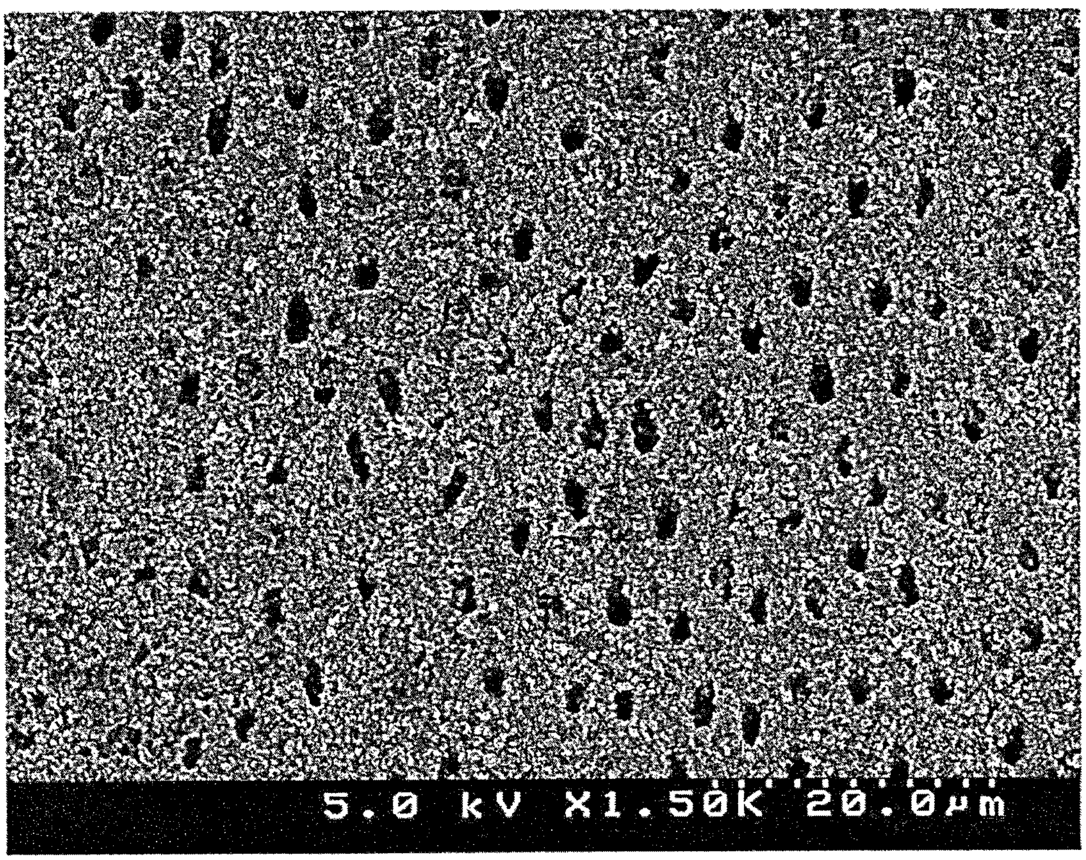
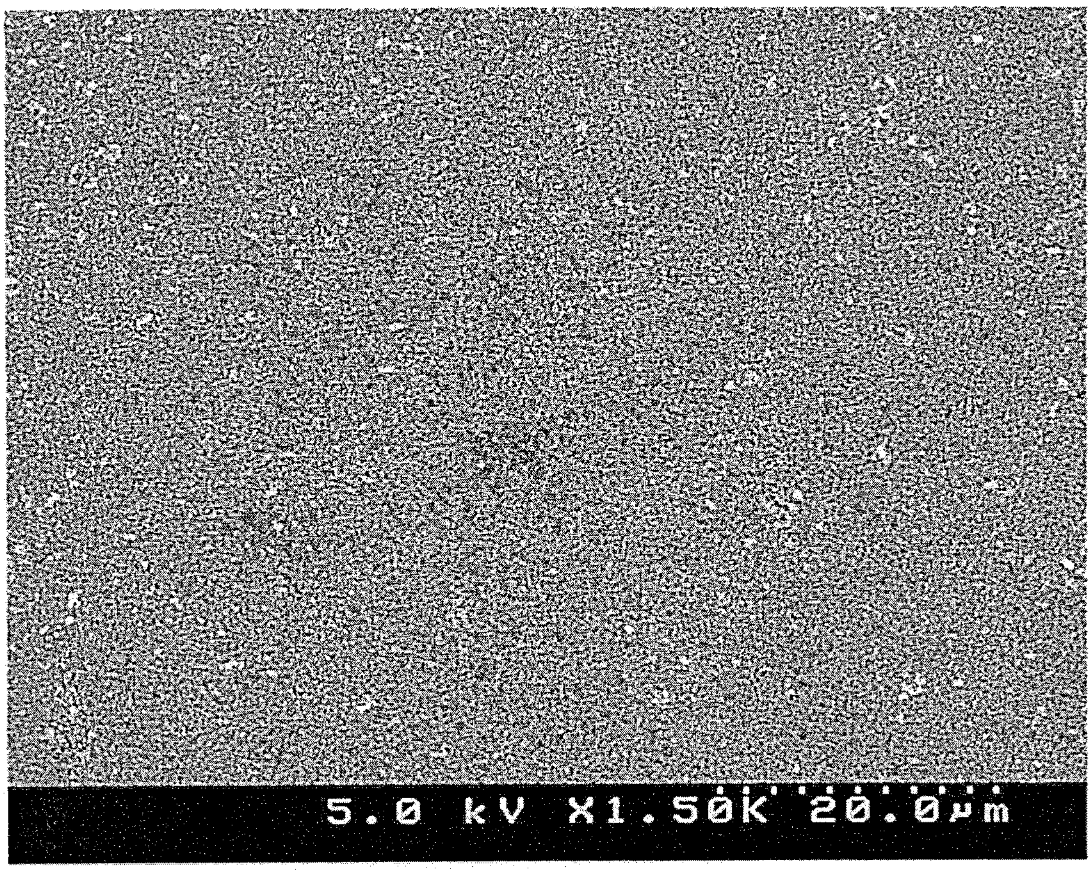


Figure 3



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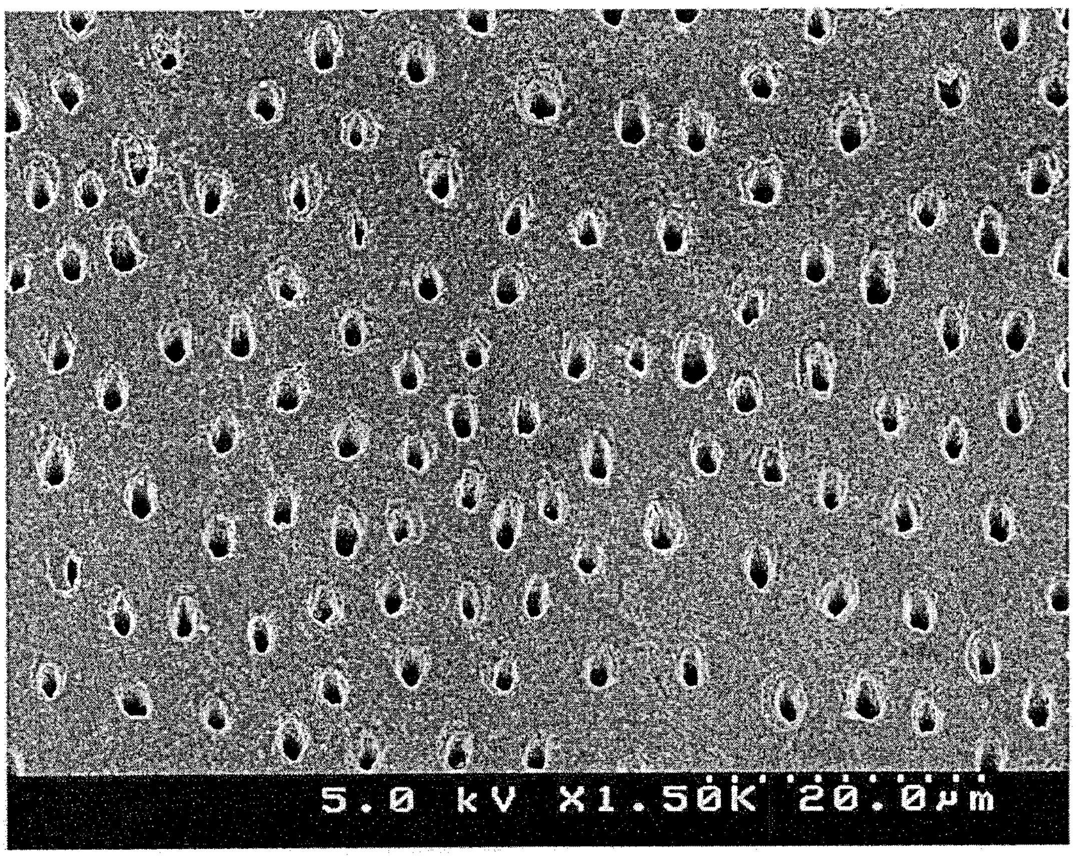


Figure 5

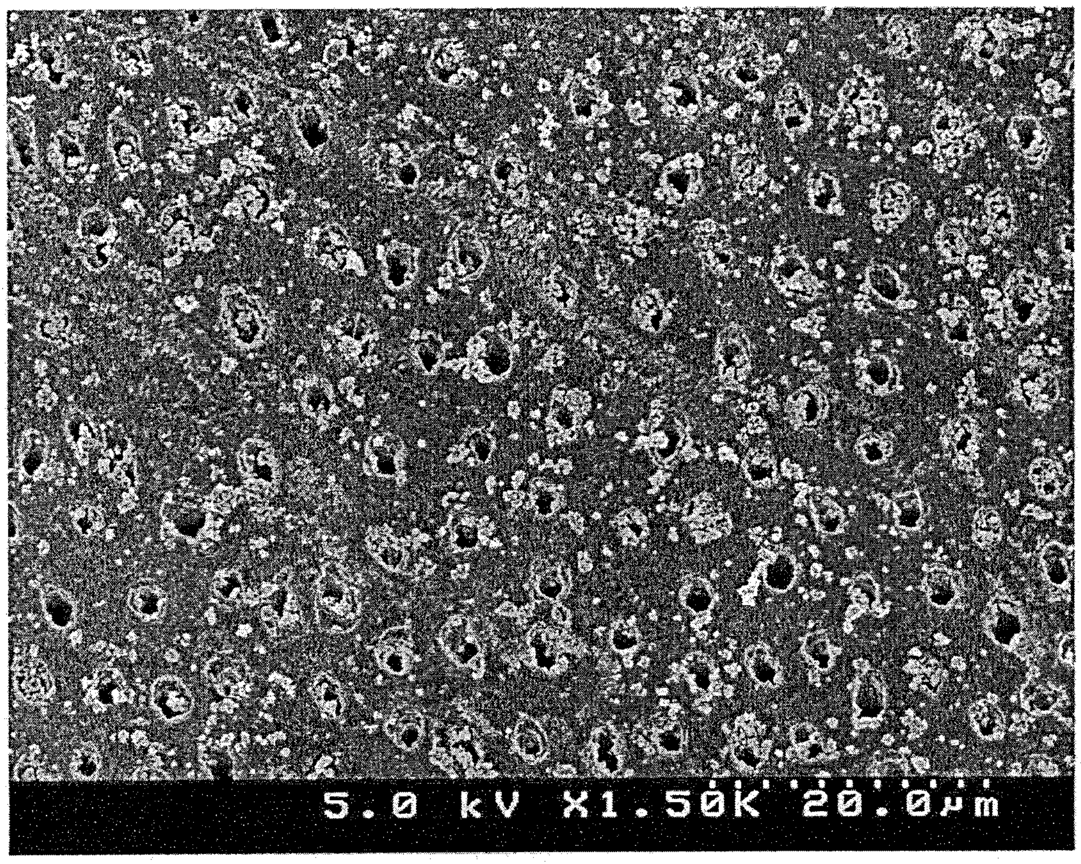


Figure 6

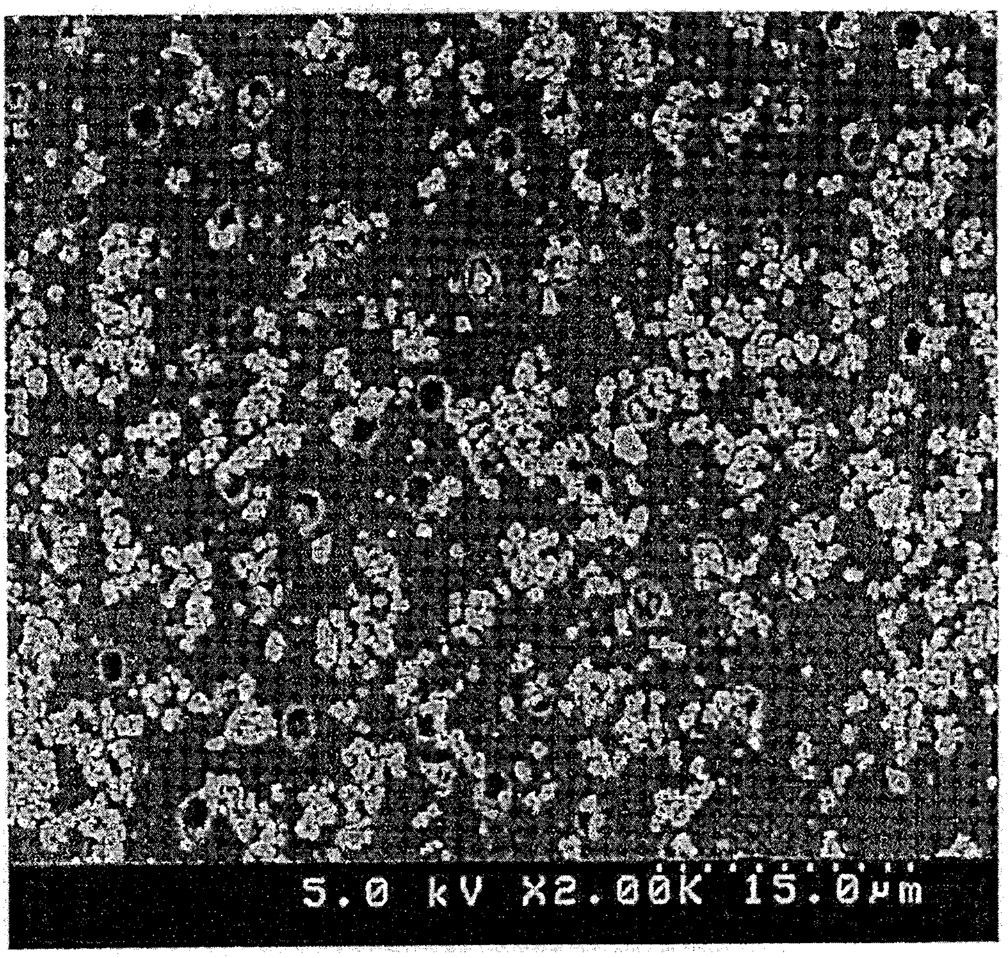


Figure 7

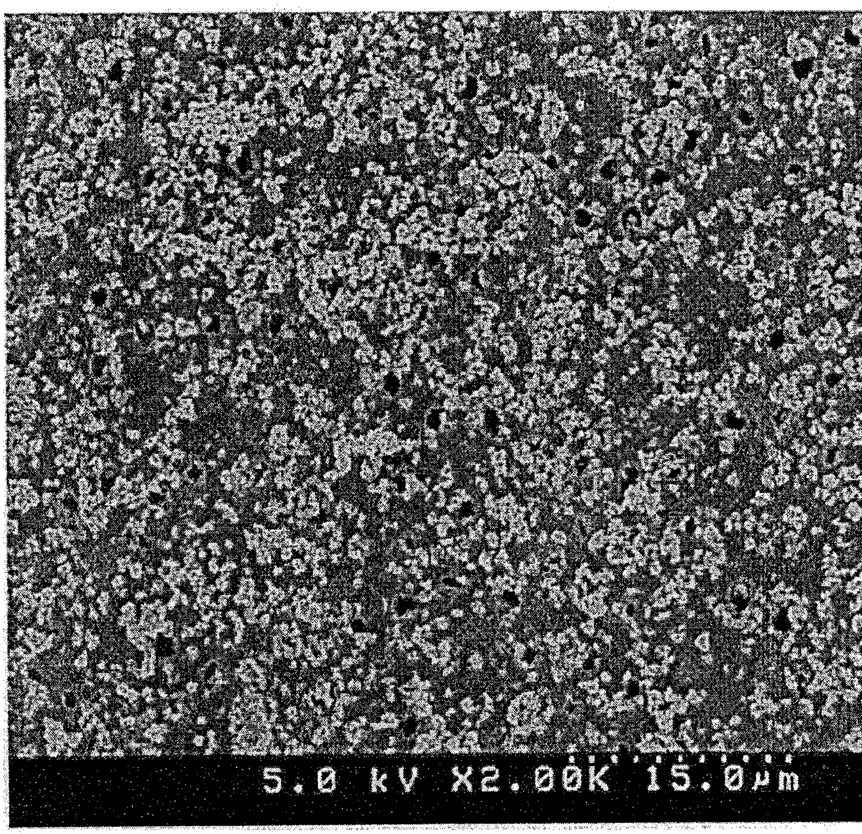
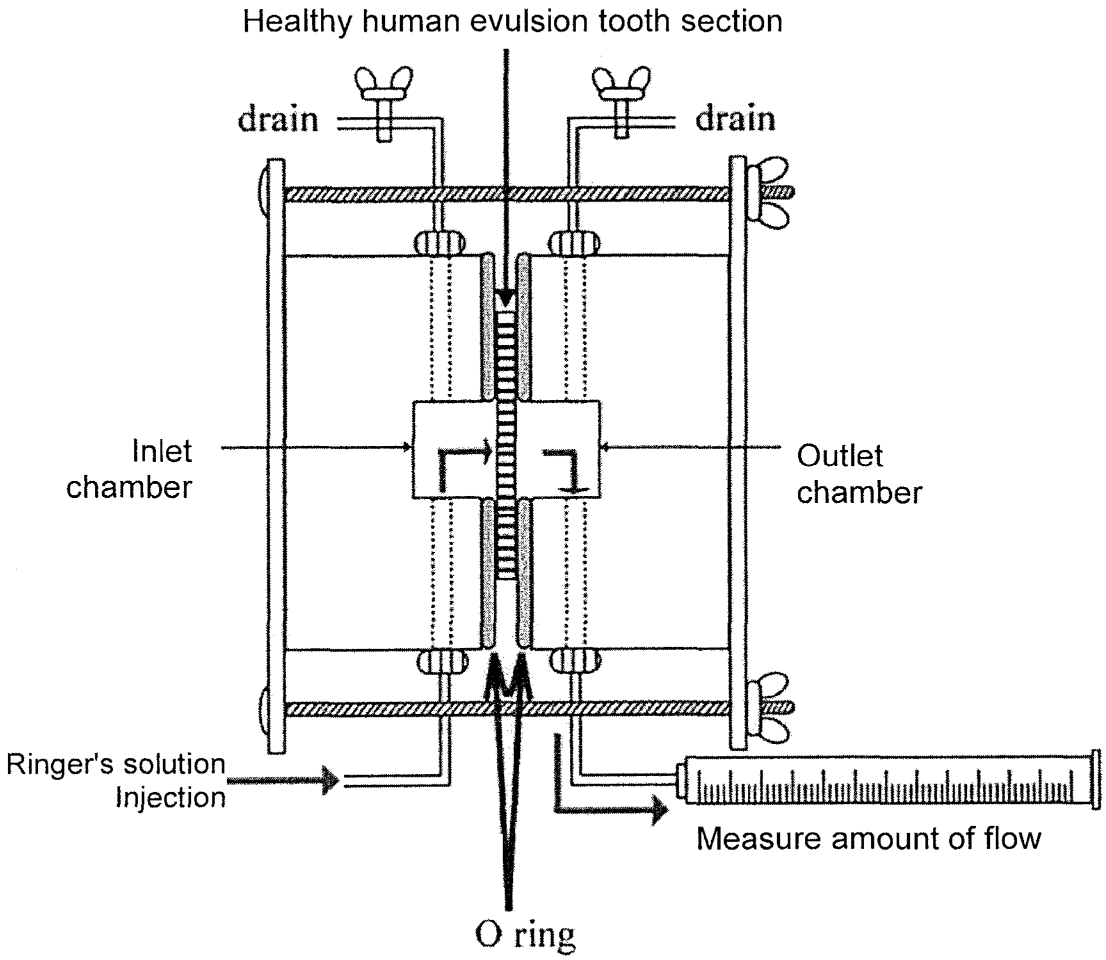


Figure 8


Healthy human evulsion tooth section
drain
drain
Inlet chamber
Outlet chamber
Ringer's solution Injection
Measure amount of flow
O ring

ORAL COMPOSITION

This application is a national phase application under 35 U.S.C. §371 of International Application No. PCT/JP2013/005231, filed Sep. 4, 2013, which claims priority to Japanese Patent Application No. 2012-195044, filed Sep. 5, 2012, the entire contents of each of which are incorporated herein by reference.

TECHNICAL FIELD

The present invention relates to oral compositions that promote occlusion of a dentinal tubule of a tooth to inhibit hypersensitivity.

BACKGROUND ART

When having cold or hot stuff and/or sweet or sour stuff in the mouth, people sometimes feel acute electrical tooth pain. This is generally called hypersensitivity, and this occurs when gums become thinner due to, for example, periodontitis and the dentin of a tooth root is then exposed and/or when enamel is damaged and the dentin is then exposed. Accordingly, this is also called dentin hypersensitivity. This dentin hypersensitivity is believed to occur when dentinal tubules on the surface of dentin have openings and physical and chemical stimulation such as brushing and/or temperature stimulation is given to the openings. However, there have been various theories on the mechanism of its onset and the mechanism is thus not fully understood. Nowadays, the "hydrodynamic theory," in which brushing and/or temperature stimulation, for example, is given and the internal fluid of dentinal tubules then moves, seems to be plausible.

In addition, during bleaching treatment so as to effectively achieve beautiful appearance, there is a concern about the hypersensitivity problem. Hence, a method for inhibiting dentin hypersensitivity has been sought.

Some dentinal tubule occlusion methods, one means for inhibiting the dentin hypersensitivity, have been proposed, including: for example, a method (Patent Document 1) using a dental therapeutic agent for hypersensitivity, the agent comprising an acidulated phosphate fluoride-tannic acid solution component, a lanthanum chloride aqueous solution component, and fluoroapatite-based glass powder; and a method (Patent Document 2) using a therapeutic agent for dentin hypersensitivity, the agent consisting of an oxalic acid compound solution and a calcium compound solution. Other dentinal tubule occlusion methods using hydroxyapatite have also been proposed, including: a method (Patent Document 3) using a composition for hypersensitivity, the composition using hydroxyapatite with a particle size of from 1.0 μm to 5.0 μm; and a method (Patent Document 4) using a sealant for dentinal tubules while sintered hydroxyapatite particles with a particle size of 900 nm or less are used for the dentinal tubule sealant.

Further, the following has been proposed, including: a hypersensitivity-inhibiting dentifrice (Patent Document 5) comprising potassium nitrate and stannous fluoride as an oral composition using potassium nitrate that functions as an agent for alleviating and inhibiting hypersensitivity; an oral composition (Patent Document 6) in which amino acid and a salt thereof or nucleic acid and a salt thereof are blended in an oral composition comprising potassium nitrate; an oral composition (Patent Document 7) comprising specific concentrations of a potassium salt and an aluminum salt; and an oral composition (Patent Document 8) in which potassium nitrate and reduced palatinose are blended.

Meanwhile, calcium monohydrogen phosphate dihydrate (dibasic calcium phosphate) is used as, for example, a base material for dentifrice, a cleaning agent, or a polishing agent. Some oral compositions using calcium monohydrogen phosphate dihydrate have been proposed, including: for example, in order to remove plaques on the surface of a tooth to increase whiteness of the tooth, a dentifrice composition (Patent Document 9) comprising aggregated particles selected from calcium carbonate, dibasic calcium phosphate, tribasic calcium phosphate, calcium pyrophosphate, and hydroxyapatite, the particles having an average particle size of 3.5 to 10 μm and a disintegration strength of 0.1 to 5 g/particle; and in order to effectively remove tooth colorants without significantly damaging a tooth, a dentifrice composition (Patent Document 10) comprising: granules having an average particle size of 100 to 500 μm and a disintegration strength of 0.1 to 10 g/granule, the granules being prepared using powder as a polishing agent such as dibasic calcium phosphate, tribasic calcium phosphate, calcium pyrophosphate, magnesium phosphate, insoluble sodium metaphosphate, silica, hydroxyapatite, aluminum hydroxide, alumina, calcium carbonate, magnesium carbonate, calcium sulfate, zeolite, an aluminosilicate complex, and red iron oxide; and at least one polishing powder selected from zeolite, calcium carbonate, dibasic calcium phosphate anhydride, tribasic calcium phosphate, hydroxyapatite, and aluminum hydroxide, the powder particles having a Mohs' hardness of 2 to 6 and an average particle size of 0.5 to 5 μm.

PRIOR ART DOCUMENTS

Patent Documents

Patent Document 1: Japanese unexamined Patent Application Publication No. 09-249515

Patent Document 2: Japanese unexamined Patent Application Publication No. 2001-247456

Patent Document 3: Japanese unexamined Patent Application Publication No. 10-17449

Patent Document 4: Japanese unexamined Patent Application Publication No. 2005-325102

Patent Document 5: Japanese unexamined Patent Application Publication (Translation of PCT Application) No. 2002-512177

Patent Document 6: Japanese unexamined Patent Application Publication No. 08-175943

Patent Document 7: Japanese unexamined Patent Application Publication No. 2001-172146

Patent Document 8: Japanese unexamined Patent Application Publication No. 2003-73246

Patent Document 9: Japanese unexamined Patent Application Publication No. 2000-154126

Patent Document 10: Japanese unexamined Patent Application Publication No. 10-316547

SUMMARY OF THE INVENTION

Object to be Solved by the Invention

It is an object of the present invention to provide an oral composition that has an increased ability to occlude dentinal tubules of a tooth and has an excellent inhibitory effect on hypersensitivity.

Means to Solve the Object

The present inventors have conducted intensive research so as to solve the above object and have found that simultaneously blending hydroxyapatite, which has been known to have an ability to occlude dentinal tubules of a tooth, with calcium monohydrogen phosphate and potassium nitrate, which has not been known to have the ability to occlude dentinal tubules of a tooth, results in an unexpected increase in occlusion of the dentinal tubules of a tooth. Then, the present invention has been completed. The present inventors have found an unexpected effect in which: potassium nitrate, in particular, does not have an ability to occlude dentinal tubules of a tooth when used alone and does not exhibit a particular effect when mixed with either hydroxyapatite or calcium monohydrogen phosphate; and potassium nitrate, however, can markedly increase the ability to occlude dentinal tubules of a tooth when combined with both hydroxyapatite and calcium monohydrogen phosphate.

Specifically, the present invention relates to: (1) an oral composition having an ability to occlude a dentinal tubule of a tooth, the composition comprising hydroxyapatite, potassium nitrate, and calcium monohydrogen phosphate; (2) the oral composition according to (1), wherein the calcium monohydrogen phosphate is calcium monohydrogen phosphate dihydrate; (3) the oral composition according to the above (1) or (2), wherein an amount of hydroxyapatite in the composition is 0.5 to 20% by weight; (4) the oral composition according to any one of the above (1) to (3) wherein an amount of potassium nitrate in the composition is 2.5 to 10% by weight; and (5) the oral composition according to any one of the above (1) to (4), wherein an amount of calcium monohydrogen phosphate in the composition is 0.5 to 25% by weight in calcium monohydrogen phosphate dihydrate equivalent.

Effect of the Invention

An oral composition according to the present invention is an oral composition comprising three components of hydroxyapatite, potassium nitrate, and calcium monohydrogen phosphate as active ingredients. The oral composition has an increased ability to occlude dentinal tubules and is very effective in inhibiting hypersensitivity.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** is a photograph showing an untreated dentin surface.

FIG. **2** is a photograph showing a dentin surface after soaking treatment according to Example 15.

FIG. **3** is a photograph showing a dentin surface after soaking treatment according to Example 30.

FIG. **4** is a photograph showing a dentin surface after soaking treatment according to Comparative Example 11.

FIG. **5** is a photograph showing a dentin surface after soaking treatment according to Comparative Example 30.

FIG. **6** is a photograph showing a dentin surface after soaking treatment according to Comparative Example 31.

FIG. **7** is a photograph showing a dentin surface after soaking treatment according to Comparative Example 43.

FIG. **8** illustrates a split chamber device used for a test for liquid permeation through dentinal tubules.

MODE FOR CARRYING OUT THE INVENTION

An oral composition having an ability to occlude dentinal tubules of a tooth according to the present invention is not particularly limited as long as the composition contains hydroxyapatite, potassium nitrate, and calcium monohydrogen phosphate. As a form of the oral composition according to the present invention, any form may be employed, including a solid, solidified product, liquid, fluid, gel, paste, and gum. Specific examples include: a dentifrice such as a toothpaste, a liquid dentifrice, a fluid dentifrice, and a tooth semi-paste; a mouthwash; and an ointment.

An oral composition according to the present invention exerts the unexpected effect of synergistically increasing an occlusion rate of dentinal tubules of a tooth by including three components of hydroxyapatite, potassium nitrate, and calcium monohydrogen phosphate. That is, although any two components of these three components are mixed, no effect of synergistically increasing the occlusion rate of dentinal tubules is observed. However, once all the three components are blended, the effect of synergistically increasing the occlusion rate of dentinal tubules of a tooth can be recognized (see Examples for details).

Hydroxyapatite used in the present invention is a kind of calcium phosphate. The hydroxyapatite may be those synthesized using a common procedure or may be those obtained as a natural hard tissue from, for example, a fish bone of food fish such as a salmon, a pork bone, and a bovine bone. Hydroxyapatite usually has a stoichiometric composition of $Ca_{10}(PO_4)_6(OH)_2$. Even if the Ca/P molar ratio is non-stoichiometric and is not 1.67, the hydroxyapatite exhibits its own specific characteristics and can have an apatite structure. For example, synthetic hydroxyapatite having a Ca/P molar ratio of about 1.4 to 1.8 is included in the hydroxyapatite according to the present invention.

The hydroxyapatite used in the present invention may be any of crystalline, low crystalline, or amorphous ones. In view of a dental caries prevention effect, it is preferable to use low crystalline or amorphous hydroxyapatite (hereinafter, the low crystalline hydroxyapatite and the amorphous hydroxyapatite are referred to as "amorphous hydroxyapatite"). Note that the term "low crystalline" refers to a state in which a crystalline substance has a broader X-ray diffraction peak than high crystalline powder. The term "amorphous" refers to a state in which a substance exhibits a broad harrow in an X-ray diffraction pattern and no crystal-specific diffraction pattern. Such amorphous hydroxyapatite can be obtained by, for example, subjecting apatite synthesized using a wet synthesis method to lyophilization or drying at a temperature of 100° C. or lower or by firing the apatite at a temperature of about 300° C. or lower.

The hydroxyapatite according to the present invention may be usually used as powder or in a water suspension state. The hydroxyapatite has a maximum particle size of preferably 100 μm or less as measured using a laser diffraction/scattering particle size distribution analyzer (LA-950, manufactured by Horiba, Ltd.). The lower limit of the particle size is about 0.001 μm in view of production. In addition, the average particle size is preferably from 0.01 to 10 μm and more preferably from 0.05 to 5 μm. Note that the hydroxyapatite has a specific surface area of about 100 m^2/g or less as measured using a BET method. In addition, depending on the need, the hydroxyapatite can be made into powder, followed by subjecting the powder to drying and by making the resulting powder porous and electrostatic, etc., for usage.

A larger amount of hydroxyapatite in an oral composition according to the present invention is preferable in view of increasing occlusion of dentinal tubules of a tooth. When a formulation viewpoint such as viscosity is taken into consideration, the amount blended is preferably from 0.5 to 20% by weight, more preferably from 1 to 10% by weight, and still more preferably from 5 to 10% by weight. Hydroxyapatite has been previously known to have the action of occluding dentinal tubules of a tooth. As described above, in view of increasing the occlusion of dentinal tubules of a tooth, a larger amount blended is preferable. However, according to the present invention, a combination of hydroxyapatite with potassium nitrate and calcium monohydrogen phosphate can synergistically increase the above effect. Hence, this makes it possible to decrease a usage amount of expensive hydroxyapatite.

The potassium nitrate used in the present invention is a kind of nitrate represented by a chemical formula: KNO_3. Examples of the potassium nitrate that can be used include any of a food additive, a first grade reagent, and a special grade reagent. This potassium nitrate exerts an effect in which ionized potassium inhibits neural transmission to alleviate pain caused by hypersensitivity. Nowadays, this potassium nitrate has been used for a dentifrice for hypersensitivity, but has no ability to occlude dentinal tubules of a tooth (see Comparative Examples 8 to 11). However, according to the present invention, a combination of this potassium nitrate with both hydroxyapatite and calcium monohydrogen phosphate is used to exert the unexpected effect of markedly increasing occlusion of dentinal tubules of a tooth.

In view of increasing occlusion of dentinal tubules of a tooth, a larger amount of potassium nitrate in an oral composition according to the present invention is preferable. When a formulation viewpoint such as viscosity is taken into consideration, the amount blended is preferably from 2.5 to 10% by weight and more preferably from 5 to 10% by weight.

The calcium monohydrogen phosphate used in the present invention is a kind of calcium phosphate represented by a chemical formula: $CaHPO_4$. The calcium monohydrogen phosphate may be an anhydride or a hydrate. In view of moisture absorption and stability, the calcium monohydrogen phosphate is preferably calcium monohydrogen phosphate dihydrate (DCPD) represented by a chemical formula: $CaHPO_4.2H_2O$. Calcium monohydrogen phosphate dihydrate has been widely used as a pharmaceutical excipient, a calcium enhancer, a base material for dentifrice, a feed additive, a synthetic resin modifier, a glaze raw material, or a ceramic raw material. Examples of the calcium monohydrogen phosphate dihydrate used in the present invention may include any kind described in the Japanese Standards of Food Additives, the Japanese Pharmacopoeia, the Japanese Standards of Quasi-drug Ingredients 2006, and the like. In addition, in the case of using, for example, anhydrous calcium phosphate as calcium monohydrogen phosphate, stable calcium monohydrogen phosphate dihydrate is present during adjustment and usage of an oral composition according to the present invention because the anhydrous calcium phosphate is hygroscopic.

In view of increasing occlusion of dentinal tubules of a tooth, a larger amount of calcium monohydrogen phosphate blended in an oral composition according to the present invention is preferable. When a formulation viewpoint such as viscosity is taken into consideration, the amount blended is preferably from 0.5 to 25% by weight in calcium monohydrogen phosphate dehydrate equivalent, more preferably from 1 to 20% by weight, and still more preferably from 5 to 20% by weight. The present invention reveals that even calcium monohydrogen phosphate dihydrate alone has an ability to occlude dentinal tubules of a tooth and contributes to occlusion of the dentinal tubules (see Comparative Examples 12 to 17). However, when the calcium monohydrogen phosphate dihydrate is combined with both hydroxyapatite and potassium nitrate, their occlusion can be markedly enhanced.

In addition, in order to achieve a markedly high occlusion ability, an oral composition according to the present invention preferably contains a large amount of hydroxyapatite compared with calcium monohydrogen phosphate. In order to economically achieve a predetermined high occlusion ability, the composition preferably contains a large amount of calcium monohydrogen phosphate compared with hydroxyapatite.

An oral composition according to the present invention can contain, in addition to the above-described three essential components, various components such as an additive, a moisturizer, a foaming agent, a flavoring agent, a sweetener, and a preservative that can be usually used in the oral composition. The following describes specific examples of these components. Note that components that can be blended in an oral composition according to the present invention are not limited to these components.

Examples of a polishing agent include calcium phosphate, tribasic calcium phosphate, calcium carbonate, calcium pyrophosphate, silica such as polishing precipitated silica and polishing gel silica, calcium silicate, aluminum silicate, aluminum oxide, aluminum hydroxide, alumina, zeolite, titanium oxide, zirconium silicate, insoluble sodium metaphosphate, tribasic magnesium phosphate, magnesium carbonate, calcium sulfate, magnesium sulfate, methyl polymethacrylate, bentonite, and a synthetic resin.

Examples of the moisturizer include polyhydric alcohol such as glycerin, propylene glycol, polyethylene glycol, sorbitol, xylitol, ethylene glycol, 1,3-butylene glycol, and isopropylene glycol.

Examples of the foaming agent include sodium lauryl sulfate, an N-lauroylsarcosine sodium salt, and a nonionic surfactant.

Examples of a thickener include hydroxyethyl cellulose, sodium carboxymethyl cellulose, carrageenan, a carboxyvinyl polymer, xanthan gum, gelatin, pullulan, sodium alginate, sodium polyacrylate, polyvinyl alcohol, locust bean gum, guar gum, and hydroxypropyl methylcellulose.

Examples of a binder include methyl cellulose, propylene glycol alginate, pullulan, tragacanth gum, xanthan gum, pectin, furcellaran, chitosan, polyethylene oxide, polyvinylpyrrolidone, polyacrylic acid, polymethacrylic acid, peptone, casein, collagen, albumin, gum arabic, karaya gum, eudragit, ethyl cellulose, cellulose acetate, sodium polyacrylate, polyvinyl alcohol, polyvinyl acetal•dimethylamino acetate, and cellulose acetate•dibutylhydroxypropyl ether.

Examples of an emulsifier include polyoxyethylene hydrogenated castor oil, sorbitan monostearate, glycerin fatty acid ester, propyleneglycol fatty acid ester, alkyl glyceryl ether, polyoxyethylene sorbitol fatty acid ester, polysorbate, polyoxyethylene, lauromacrogol, sodium alkyl sulfate, alkyl phosphate, sodium alkyl benzene sulfonate, sodium N-acyl sarcosinate, N-acyl glutamate, sucrose fatty acid ester, alkyl glycosides, alkyldimethylamine oxide, and alkyl betaines.

Examples of a fat and oil component include liquid paraffin, paraffin, higher alcohol such as cetyl alcohol and stearyl alcohol, fatty acid ester such as isopropyl myristate, lanolin, whale wax, carnauba wax, fatty acids, an ester compound such as octyl dodecyl myristate, diisopyl adipate, hexadecyl isostearate, and decyl oleate, squalane, squalene, medium chain fatty acid triglyceride, and silicon.

Examples of alcohol include: lower alcohol such as ethanol, propyl alcohol, isopropyl alcohol, butanol, and isobutanol; and polyhydric alcohol such as ethylene glycol, diethylene glycol, propylene glycol, dipropylene glycol, 1,3-butylene glycol, glycerin, 1,5-pentadiol, sorbitol, and polyethylene glycol.

Examples of a surfactant are listed as follows. Examples of a nonionic surfactant include sorbitan fatty acid ester, glycerin fatty acid ester, decaglycerin fatty acid ester, polyglycerin fatty acid ester, propylene glycol•pentaerythritol fatty acid ester, polyoxyethylene sorbitan fatty acid ester, polyoxyethylene glycerin fatty acid ester, polyoxyethylene sorbitol fatty acid ester, polyethylene glycol fatty acid ester, polyoxyethylene alkylether, polyoxyethylene polyoxypropylene glycol, polyoxypropylene alkylether, polyoxyethylene polyoxypropylene alkylether, polyoxyethylene alkylphenyl ether, polyoxyethylene castor oil•hydrogenated castor oil, a polyoxyethylene lanolin•lanolin alcohol•bees wax derivative, polyoxyethylene alkylamine•fatty acid amide, a polyoxyethylene alkylphenyl formaldehyde condensate, and single chain length polyoxyethylene alkylether. Examples of an anionic surfactant include sodium lauryl sulfate, sodium myristyl sulfate, alkyl sulfate, polyoxyethylene alkyl sulfate, N-acyl amino acid and a salt thereof, N-acyl methyl taurine and a salt thereof, polyoxyethylene alkylether acetate, alkyl sulfocarboxylate, α-olefin sulfonate, alkyl phosphate, and polyoxyethylene alkylether phosphate. Examples of a cationic surfactant include alkyl ammonium, and an alkylbenzyl ammonium salt. Examples of an amphoteric surfactant include betaine acetate, imidazolinium betaine, and lecithin. Examples of the nonionic surfactant further include sucrose fatty acid ester and decaglyceryl laurate.

Examples of a pH modifier include citric acid and a salt thereof, phosphoric acid and a salt thereof, malic acid and a salt thereof, gluconic acid and a salt thereof, maleic acid and a salt thereof, aspartic acid and a salt thereof, gluconic acid and a salt thereof, succinic acid and a salt thereof, glucuronic acid and a salt thereof, fumaric acid and a salt thereof, glutamic acid and a salt thereof, adipic acid and a salt thereof, inorganic acid such as hydrochloric acid, hydrofluoric acid, alkali metal hydroxide such as sodium hydroxide and potassium hydroxide, and amines such as triethanolamine, diethanolamine, and diisopropanolamine.

Examples of the preservative include paraoxybenzoate, alkyldiaminoethylglycine hydrochloride, methylparaben, ethylparaben, and sodium benzoate.

Examples of a stabilizer include sodium sulfite, sodium hydrogen sulfite, dibutylhydroxy toluene, butylhydroxyanisole, and edetic acid or salts thereof.

Examples of the flavoring agent include menthol, essential oil from peppermint or spearmint, eucalyptus oil, orange oil, lemon oil, wintergreen oil, clove oil, Japanese peppermint oil, thyme oil, sage oil, carvone, linalool, eugenol, anethole, and herb mint.

Examples of the stabilizer further include vitamin C, vitamin E, and a derivative thereof, sodium sulfite, sodium pyrosulfite, sodium hydrogen sulfite, butyl hydroxy toluene, and butylhydroxyanisole.

Examples of the sweetener include saccharin sodium, aspartame, stevioside, neohesperidin dihydrochalcone, glycyrrhizin, aspartylphenyl alanine methyl ester, acesulfame potassium, perillatin, p-methoxy cinnamic aldehyde, and xylitol.

Examples of other medicinal ingredients include allantoin, tocopherol acetate, isopropylphenol, triclosan, chlorhexidine, chlorophyll, flavonoid, tranexamic acid, hinokitiol, cetylpyridinium chloride, sodium fluoride, stannous fluoride, sodium monofluorophosphate, dextranase, mutanase, protease, aminocaproic acid, glycyrrhizic acid, glycyrrhetic acids, azulene, allantoin, lysozyme chloride, *Hordeum sativum* extract, polyphosphoric acids, and sodium chloride.

Note that an amount of each of these optional components blended is suitably used within a pharmacologically acceptable range without hindering the effects of the present invention. In addition, it may be possible to add hydroxyapatite, potassium nitrate, calcium monohydrogen phosphate, and the other optional components in any step during the production of an oral composition according to the present invention.

EXAMPLES

Example 1

The following details the present invention with reference to Examples. The technical scope of the present invention, however, is not limited to the following Examples.

Production of Hydroxyapatite

First, a phosphoric acid aqueous solution having a concentration of 30% by mass was dropwise added to a calcium hydroxide suspension under stirring until a pH became 10. Produced gelatinous substance was left and matured at room temperature for 1 day. Next, the gelatinous substance was filtered with a glass filter. Then the residue was dried in the air at 100° C. to yield hydroxyapatite powder. The resulting hydroxyapatite powder had a maximum particle size of about 40 μm, a minimum particle size of about 0.05 μm, and an average particle size of about 5 μm.

Potassium Nitrate

A special grade reagent, manufactured by Wako Pure Chemical Industries, Ltd., was used as potassium nitrate.

Calcium Monohydrogen Phosphate Dihydrate

A raw material standard 2006, a quasi-medicine, manufactured by Taihei Chemical Industrial Co., Ltd., was used as calcium monohydrogen phosphate dihydrate.

Preparation of Oral Compositions According to Examples and Comparative Examples

Toothpastes, mouthwashes, and dentinal tubule-occluding agents having the following compositions were manufactured according to a common procedure, and a dentinal tubule occlusion test was conducted.

TABLE 1

	Toothpastes					
	Example 1	Example 2	Example 3	Example 4	Example 5	Example 6
Hydroxyapatite	0.5	0.5	0.5	0.5	0.5	0.5
Potassium nitrate	2.5	2.5	5.0	5.0	10.0	10.0
Calcium monohydrogen	0.5	25.0	5.0	20.0	0.5	25.0

TABLE 1-continued

Toothpastes	Example 1	Example 2	Example 3	Example 4	Example 5	Example 6
phosphate dihydrate						
Glycerin	20.0	20.0	20.0	20.0	20.0	20.0
Polyethylene glycol	3.0	3.0	3.0	3.0	3.0	3.0
Sodium lauryl sulfate	1.0	1.0	1.0	1.0	1.0	1.0
Xanthan gum	0.5	0.5	0.5	0.5	0.5	0.5
Hydroxyethyl cellulose	0.5	0.5	0.5	0.5	0.5	0.5
Menthol	0.5	0.5	0.5	0.5	0.5	0.5
Purified water	balancer	balance	balance	balance	balance	balance
Total	100.0	100.0	100.0	100.0	100.0	100.0

TABLE 2

Toothpastes	Example 7	Example 8	Example 9	Example 10	Example 11	Example 12
Hydroxyapatite	1.0	1.0	1.0	1.0	1.0	1.0
Potassium nitrate	2.5	2.5	5.0	5.0	10.0	10.0
Calcium monohydrogen phosphate dihydrate	0.5	25.0	5.0	10.0	0.5	25.0
Glycerin	20.0	20.0	20.0	20.0	20.0	20.0
Polyethylene glycol	3.0	3.0	3.0	3.0	3.0	3.0
Sodium lauryl sulfate	1.0	1.0	1.0	1.0	1.0	1.0
Xanthan gum	0.5	0.5	0.5	0.5	0.5	0.5
Hydroxyethyl cellulose	0.5	0.5	0.5	0.5	0.5	0.5
Menthol	0.5	0.5	0.5	0.5	0.5	0.5
Purified water	balance	balance	balance	balance	balance	balance
Total	100.0	100.0	100.0	100.0	100.0	100.0

TABLE 3

Toothpastes	Example 13	Example 14	Example 15	Example 16	Example 17	Example 18
Hydroxyapatite	5.0	5.0	5.0	5.0	5.0	5.0
Potassium nitrate	2.5	2.5	5.0	7.5	10.0	10.0
Calcium monohydrogen phosphatedihydrate	0.5	25.0	10.0	10.0	0.5	25.0
Glycerin	20.0	20.0	20.0	20.0	20.0	20.0
Polyethylene glycol	3.0	3.0	3.0	3.0	3.0	3.0
Sodium lauryl sulfate	1.0	1.0	1.0	1.0	1.0	1.0
Xanthan gum	0.5	0.5	0.5	0.5	0.5	0.5
Hydroxyethyl cellulose	0.5	0.5	0.5	0.5	0.5	0.5
Menthol	0.5	0.5	0.5	0.5	0.5	0.5
Purified water	balance	balance	balance	balance	balance	balance
Total	100.0	100.0	100.0	100.0	100.0	100.0

TABLE 4

Toothpastes	Example 19	Example 20	Example 21	Example 22	Example 23	Example 24
Hydroxyapatite	10.0	10.0	10.0	10.0	10.0	10.0
Potassium nitrate	2.5	2.5	5.0	7.5	10.0	10.0

TABLE 4-continued

Toothpastes	Example 19	Example 20	Example 21	Example 22	Example 23	Example 24
Calcium monohydrogen phosphatedihydrate	0.5	25.0	1.0	20.0	0.5	25.0
Glycerin	20.0	20.0	20.0	20.0	20.0	20.0
Polyethylene glycol	3.0	3.0	3.0	3.0	3.0	3.0
Sodium lauryl sulfate	1.0	1.0	1.0	1.0	1.0	1.0
Xanthan gum	0.5	0.5	0.5	0.5	0.5	0.5
Hydroxyethyl cellulose	0.5	0.5	0.5	0.5	0.5	0.5
Menthol	0.5	0.5	0.5	0.5	0.5	0.5
Purified water	balance	balance	balance	balance	balance	balance
Total	100.0	100.0	100.0	100.0	100.0	100.0

TABLE 5

Toothpastes	Example 25	Example 26	Example 27	Example 28	Example 29	Example 30
Hydroxyapatite	20.0	20.0	20.0	20.0	20.0	20.0
Potassium nitrate	2.5	2.5	5.0	7.5	10.0	10.0
Calcium monohydrogen phosphatedihydrate	0.5	25.0	20.0	5.0	0.5	25.0
Glycerin	20.0	20.0	20.0	20.0	20.0	20.0
Polyethylene glycol	3.0	3.0	3.0	3.0	3.0	3.0
Sodium lauryl sulfate	1.0	1.0	1.0	1.0	1.0	1.0
Xanthan gum	0.5	0.5	0.5	0.5	0.5	0.5
Hydroxyethyl cellulose	0.5	0.5	0.5	0.5	0.5	0.5
Menthol	0.5	0.5	0.5	0.5	0.5	0.5
Purified water	balance	balance	balance	balance	balance	balance
Total	100.0	100.0	100.0	100.0	100.0	100.0

TABLE 6

Toothpastes	Comparative Example 2	Comparative Example 3	Comparative Example 4	Comparative Example 5	Comparative Example 6	Comparative Example 7
Hydroxyapatite	—	0.5	1.0	5.0	10.0	20.0
Potassium nitrate	—	—	—	—	—	—
Calcium monohydrogen phosphate dihydrate	—	—	—	—	—	—
Glycerin	20.0	20.0	20.0	20.0	20.0	20.0
Polyethylene glycol	3.0	3.0	3.0	3.0	3.0	3.0
Sodium lauryl sulfate	1.0	1.0	1.0	1.0	1.0	1.0
Xanthan gum	0.5	0.5	0.5	0.5	0.5	0.5
Hydroxyethyl cellulose	0.5	0.5	0.5	0.5	0.5	0.5
Menthol	0.5	0.5	0.5	0.5	0.5	0.5
Purified water	balance	balance	balance	balance	balance	balance
Total	100.0	100.0	100.0	100.0	100.0	100.0

TABLE 7

Toothpastes	Comparative Example 8	Comparative Example 9	Comparative Example 10	Comparative Example 11
Hydroxyapatite	—	—	—	—
Potassium nitrate	2.5	5.0	7.5	10.0
Calcium monohydrogen phosphate dihydrate	—	—	—	—
Glycerin	20.0	20.0	20.0	20.0
Polyethylene glycol	3.0	3.0	3.0	3.0
Sodium lauryl sulfate	1.0	1.0	1.0	1.0
Xanthan gum	0.5	0.5	0.5	0.5
Hydroxyethyl cellulose	0.5	0.5	0.5	0.5
Menthol	0.5	0.5	0.5	0.5
Purified water	balance	balance	balance	balance
Total	100.0	100.0	100.0	100.0

TABLE 8

Toothpastes	Comparative Example 12	Comparative Example 13	Comparative Example 14	Comparative Example 15	Comparative Example 16	Comparative Example 17
Hydroxyapatite	—	—	—	—	—	—
Potassium nitrate	—	—	—	—	—	—
Calcium monohydrogen phosphate dihydrate	0.5	1.0	5.0	10.0	20.0	25.0
Glycerin	20.0	20.0	20.0	20.0	20.0	20.0
Polyethylene glycol	3.0	3.0	3.0	3.0	3.0	3.0
Sodium lauryl sulfate	1.0	1.0	1.0	1.0	1.0	1.0
Xanthan gum	0.5	0.5	0.5	0.5	0.5	0.5
Hydroxyethyl cellulose	0.5	0.5	0.5	0.5	0.5	0.5
Menthol	0.5	0.5	0.5	0.5	0.5	0.5
Purified water	balance	balance	balance	balance	balance	balance
Total	100.0	100.0	100.0	100.0	100.0	100.0

TABLE 9

Toothpastes	Comparative Example 18	Comparative Example 19	Comparative Example 20	Comparative Example 21	Comparative Example 22	Comparative Example 23
Hydroxyapatite	0.5	0.5	—	0.5	0.5	—
Potassium nitrate	—	2.5	2.5	—	10.0	10.0
Calcium monohydrogen phosphate dihydrate	0.5	—	0.5	25.0	—	25.0
Glycerin	20.0	20.0	20.0	20.0	20.0	20.0
Polyethylene glycol	3.0	3.0	3.0	3.0	3.0	3.0
Sodium lauryl sulfate	1.0	1.0	1.0	1.0	1.0	1.0
Xanthan gum	0.5	0.5	0.5	0.5	0.5	0.5
Hydroxyethyl cellulose	0.5	0.5	0.5	0.5	0.5	0.5
Menthol	0.5	0.5	0.5	0.5	0.5	0.5
Purified water	balance	balance	balance	balance	balance	balance
Total	100.0	100.0	100.0	100.0	100.0	100.0

TABLE 10

Toothpastes	Comparative Example 24	Comparative Example 25	Comparative Example 26	Comparative Example 27	Comparative Example 28	Comparative Example 29
Hydroxyapatite	1.0	1.0	—	1.0	1.0	—
Potassium nitrate	—	5.0	5.0	—	2.5	2.5
Calcium monohydrogen phosphate dihydrate	5.0	—	5.0	25.0	—	25.0
Glycerin	20.0	20.0	20.0	20.0	20.0	20.0
Polyethylene glycol	3.0	3.0	3.0	3.0	3.0	3.0

TABLE 10-continued

	Toothpastes					
	Comparative Example 24	Comparative Example 25	Comparative Example 26	Comparative Example 27	Comparative Example 28	Comparative Example 29
Sodium lauryl sulfate	1.0	1.0	1.0	1.0	1.0	1.0
Xanthan gum	0.5	0.5	0.5	0.5	0.5	0.5
Hydroxyethyl cellulose	0.5	0.5	0.5	0.5	0.5	0.5
Menthol	0.5	0.5	0.5	0.5	0.5	0.5
Purified water	balance	balance	balance	balance	balance	balance
Total	100.0	100.0	100.0	100.0	100.0	100.0

TABLE 11

	Toothpastes					
	Comparative Example 30	Comparative Example 31	Comparative Example 32	Comparative Example 33	Comparative Example 34	Comparative Example 35
Hydroxyapatite	5.0	5.0	—	5.0	5.0	—
Potassium nitrate	—	5.0	5.0	—	10.0	10.0
Calcium monohydrogen phosphate dihydrate	10.0	—	10.0	0.5	—	0.5
Glycerin	20.0	20.0	20.0	20.0	20.0	20.0
Polyethylene glycol	3.0	3.0	3.0	3.0	3.0	3.0
Sodium lauryl sulfate	1.0	1.0	1.0	1.0	1.0	1.0
Xanthan gum	0.5	0.5	0.5	0.5	0.5	0.5
Hydroxyethyl cellulose	0.5	0.5	0.5	0.5	0.5	0.5
Menthol	0.5	0.5	0.5	0.5	0.5	0.5
Purified water	balance	balance	balance	balance	balance	balance
Total	100.0	100.0	100.0	100.0	100.0	100.0

TABLE 12

	Toothpastes					
	Comparative Example 36	Comparative Example 37	Comparative Example 38	Comparative Example 39	Comparative Example 40	Comparative Example 41
Hydroxyapatite	10.0	10.0	—	10.0	10.0	—
Potassium nitrate	—	7.5	7.5	—	5.0	5.0
Calcium monohydrogen phosphate dihydrate	20.0	—	20.0	1.0	—	1.0
Glycerin	20.0	20.0	20.0	20.0	20.0	20.0
Polyethylene glycol	3.0	3.0	3.0	3.0	3.0	3.0
Sodium lauryl sulfate	1.0	1.0	1.0	1.0	1.0	1.0
Xanthan gum	0.5	0.5	0.5	0.5	0.5	0.5
Hydroxyethyl cellulose	0.5	0.5	0.5	0.5	0.5	0.5
Menthol	0.5	0.5	0.5	0.5	0.5	0.5
Purified water	balance	balance	balance	balance	balance	balance
Total	100.0	100.0	100.0	100.0	100.0	100.0

TABLE 13

	Toothpastes				
	Comparative Example 42	Comparative Example 43	Comparative Example 44	Comparative Example 45	Comparative Example 46
Hydroxyapatite	20.0	20.0	20.0	20.0	—
Potassium nitrate	—	10.0	—	7.5	7.5
Calcium monohydrogen phosphate dihydrate	25.0	—	5.0	—	5.0
Glycerin	20.0	20.0	20.0	20.0	20.0
Polyethylene glycol	3.0	3.0	3.0	3.0	3.0
Sodium lauryl sulfate	1.0	1.0	1.0	1.0	1.0

TABLE 13-continued

Toothpastes					
	Comparative Example 42	Comparative Example 43	Comparative Example 44	Comparative Example 45	Comparative Example 46
Xanthan gum	0.5	0.5	0.5	0.5	0.5
Hydroxyethyl cellulose	0.5	0.5	0.5	0.5	0.5
Menthol	0.5	0.5	0.5	0.5	0.5
Purified water	balance	balance	balance	balance	balance
Total	100.0	100.0	100.0	100.0	100.0

TABLE 14

Mouthwashes						
	Example 31	Example 32	Example 33	Comparative Example 47	Comparative Example 48	Comparative Example 49
Hydroxyapatite	0.5	0.5	0.5	0.5	—	—
Potassium nitrate	2.5	5.0	10.0	—	10.0	—
Calcium monohydrogen phosphate dihydrate	0.5	0.5	0.5	—	—	0.5
Ethyl alcohol	10.0	10.0	10.0	10.0	10.0	10.0
Sodium lauryl sulfate	1.0	1.0	1.0	1.0	1.0	1.0
Glycerin	10.0	10.0	10.0	10.0	10.0	10.0
Menthol	0.4	0.4	0.4	0.4	0.4	0.4
Purified water	balance	balance	balance	balance	balance	balance
Total	100.0	100.0	100.0	100.0	100.0	100.0

TABLE 15

Mouthwashes							
	Comparative Example 50	Comparative Example 51	Comparative Example 52	Comparative Example 53	Comparative Example 54	Comparative Example 55	Comparative Example 56
Hydroxyapatite	0.5	0.5	0.5	0.5	—	—	—
Potassium nitrate	2.5	5.0	10.0	—	2.5	5.0	10.0
Calcium monohydrogen phosphate dihydrate	—	—	—	0.5	0.5	0.5	0.5
Ethyl alcohol	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Sodium lauryl sulfate	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Glycerin	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Menthol	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Purified water	balance	balance	balance	balance	balance	balance	balance
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

TABLE 16

Dentinal tubule-occluding agents						
	Example 34	Example 35	Example 36	Example 37	Example 38	Example 39
Hydroxyapatite	1.0	5.0	5.0	5.0	5.0	5.0
Potassium nitrate	2.5	5.0	10.0	2.5	5.0	7.5
Calcium monohydrogen phosphate dihydrate	1.0	0.5	5.0	10.0	15.0	20.0
Polyethylene glycol	5.0	5.0	5.0	5.0	5.0	5.0
Purified water	balance	balance	balance	balance	balance	balance
Total	100.0	100.0	100.0	100.0	100.0	100.0

TABLE 17

Dentinal tubule-occluding agents					
	Example 40	Example 41	Example 42	Example 43	Example 44
Hydroxyapatite	5.0	10.0	10.0	10.0	10.0
Potassium nitrate	10.0	2.5	5.0	7.5	10.0
Calcium monohydrogen phosphate dihydrate	20.0	20.0	25.0	25.0	25.0
Polyethylene glycol	5.0	5.0	5.0	5.0	5.0
Purified water	balance	balance	balance	balance	balance
Total	100.0	100.0	100.0	100.0	100.0

TABLE 18

Dentinal tubule-occluding agents					
	Example 45	Example 46	Example 47	Example 48	Example 49
Hydroxyapatite	15.0	15.0	15.0	15.0	20.0
Potassium nitrate	2.5	5.0	7.5	10.0	2.5
Calcium monohydrogen phosphate dihydrate	20.0	10.0	5.0	0.5	20.0
Polyethylene glycol	5.0	5.0	5.0	5.0	5.0
Purified water	balance	balance	balance	balance	balance
Total	100.0	100.0	100.0	100.0	100.0

TABLE 19

Dentinal tubule-occluding agents				
	Comparative Example 57	Comparative Example 58	Comparative Example 59	Comparative Example 60
Hydroxyapatite	1.0	5.0	10.0	20.0
Potassium nitrate	—	—	—	—
Calcium monohydrogen phosphate dihydrate	—	—	—	—
Polyethylene glycol	5.0	5.0	5.0	5.0
Purified water	balance	balance	balance	balance
Total	100.0	100.0	100.0	100.0

TABLE 20

Dentinal tubule-occluding agents				
	Comparative Example 61	Comparative Example 62	Comparative Example 63	Comparative Example 64
Hydroxyapatite	—	—	—	—
Potassium nitrate	2.5	5.0	7.5	10.0
Calcium monohydrogen phosphate dihydrate	—	—	—	—
Polyethylene glycol	5.0	5.0	5.0	5.0
Purified water	balance	balance	balance	balance
Total	100.0	100.0	100.0	100.0

TABLE 21

Dentinal tubule-occluding agents							
	Comparative Example 65	Comparative Example 66	Comparative Example 67	Comparative Example 68	Comparative Example 69	Comparative Example 70	Comparative Example 71
Hydroxyapatite	—	—	—	—	—	—	—
Potassium nitrate	—	—	—	—	—	—	—
Calcium monohydrogen phosphate dihydrate	0.5	1.0	5.0	10.0	15.0	20.0	25.0
Polyethylene glycol	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Purified water	balance	balance	balance	balance	balance	balance	balance
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

TABLE 22

Dentinal tubule-occluding agents			
	Comparative Example 72	Comparative Example 73	Comparative Example 74
Hydroxyapatite	1.0	1.0	—
Potassium nitrate	2.5	—	2.5
Calcium monohydrogen phosphate dihydrate	—	1.0	1.0
Polyethylene glycol	5.0	5.0	5.0
Purified water	balance	balance	balance
Total	100.0	100.0	100.0

TABLE 23

Dentinal tubule-occluding agents						
	Comparative Example 75	Comparative Example 76	Comparative Example 77	Comparative Example 78	Comparative Example 79	Comparative Example 80
Hydroxyapatite	5.0	5.0	—	5.0	5.0	—
Potassium nitrate	5.0	—	5.0	10.0	—	10.0
Calcium monohydrogen phosphate dihydrate	—	15.0	15.0	—	20.0	20.0
Polyethylene glycol	5.0	5.0	5.0	5.0	5.0	5.0
Purified water	balance	balance	balance	balance	balance	balance
Total	100.0	100.0	100.0	100.0	100.0	100.0

TABLE 24

Dentinal tubule-occluding agents			
	Comparative Example 81	Comparative Example 82	Comparative Example 83
Hydroxyapatite	10.0	10.0	—
Potassium nitrate	10.0	—	10.0
Calcium monohydrogen phosphate dihydrate	—	25.0	25.0
Polyethylene glycol	5.0	5.0	5.0
Purified water	balance	balance	balance
Total	100.0	100.0	100.0

TABLE 25

Dentinal tubule-occluding agents						
	Comparative Example 84	Comparative Example 85	Comparative Example 86	Comparative Example 87	Comparative Example 88	Comparative Example 89
Hydroxyapatite	15.0	15.0	—	15.0	15.0	—
Potassium nitrate	2.5	—	2.5	—	5.0	5.0
Calcium monohydrogen phosphate dihydrate	—	20.0	20.0	10.0	—	10.0
Polyethylene glycol	5.0	5.0	5.0	5.0	5.0	5.0
Purified water	balance	balance	balance	balance	balance	balance
Total	100.0	100.0	100.0	20.0	100.0	100.0

TABLE 26

Dentinal tubule-occluding agents						
	Comparative Example 90	Comparative Example 91	Comparative Example 92	Comparative Example 93	Comparative Example 94	Comparative Example 95
Hydroxyapatite	15.0	15.0	—	15.0	15.0	—
Potassium nitrate	7.5	—	7.5	—	10.0	10.0
Calcium monohydrogen phosphate dihydrate	—	5.0	5.0	0.5	—	0.5
Polyethylene glycol	5.0	5.0	5.0	5.0	5.0	5.0
Purified water	balance	balance	balance	balance	balance	balance
Total	100.0	100.0	100.0	20.0	100.0	100.0

TABLE 27

Dentinal tubule-occluding agents			
	Comparative Example 96	Comparative Example 97	Comparative Example 98
Hydroxyapatite	20.0	20.0	—
Potassium nitrate	—	2.5	2.5
Calcium monohydrogen phosphate dihydrate	20.0	—	20.0
Polyethylene glycol	5.0	5.0	5.0
Purified water	balance	balance	balance
Total	20.0	100.0	100.0

Dentinal Tubule Occlusion Test

A healthy human evulsion tooth was used to cut the tooth into sections in such a manner that dentin and dentinal tubules were exposed. The resulting sections were polished at a thickness of about 500 μm and were subjected to ultrasonic cleaning. Next, 25 g of each of the dentifrices, mouthwashes, and dentinal tubule-occluding agents of the Examples and Comparative Examples was adjusted with distilled water to have a volume of 40 mL. The resulting solution was used as a test solution. Then, the sections whose portions other than the test surface had been masked were soaked in the test solution at 37° C. for 9 min per day. This soaking treatment was conducted for 5 days.

After the soaking, the treatment surface of dentin was observed with a field emission scanning electron microscope FE-SEM (S-4500, manufactured by Hitachi, Ltd.) (magnification: 1,500× or 2,000×). FIGS. **1** to **7** show electron micrographs of the untreated surface and the treated surface of the dentin of a tooth after the soaking test. FIGS. **1** to **7** clearly demonstrate that the sections treated using an oral

composition according to the present invention exhibited occlusion of dentinal tubules of a tooth.

In addition, a test for liquid permeation through dentinal tubules was conducted. The test for liquid permeation through dentinal tubules was conducted according to the Pashley's protocol disclosed in "O. W. Reeder et al., J. Dent. Res., 57, (2); 187-193, 1978." A split chamber device shown in FIG. **8** was prepared and put into practice. A dentin section was interposed between an inlet chamber and an outlet chamber of the above device. Then, the test solution was placed in the inlet chamber to treat the dentin surface. In addition, a Ringer's solution was injected using pressure in the inlet chamber before and after the treatment. By measuring the amount of flow through the outlet chamber, the liquid permeation through dentinal tubules was evaluated.

As a Comparative Example for the dentifrice, a commercially available dentifrice (containing aluminum lactate known to have an ability to occlude dentinal tubules of a tooth), which was sold and advertised to have a hypersensitivity-inhibiting effect, was used (in Comparative Example 1).

The effect of inhibiting liquid permeation through dentinal tubules of each test solution was determined as follows: first, a difference between the amount of flow of the Ringer's solution before and that after the treatment was determined; and a liquid permeation inhibition rate of the dentinal tubules was then calculated in percent units by using the following equation.

$$\text{Occlusion rate (\%)} = (\text{Amount of flow before treatment} - \text{Amount of flow after treatment})/(\text{Amount of flow before treatment}) \times 100.$$

Table 28 shows the results.

TABLE 28

Toothpastes	Example/Comparative Example	Example 1	Example 2	Example 3	Example 4	Example 5	Example 6	
	Dentinal tubule occlusion rate (%)	29.6	49	39.7	48.9	34.5	53.7	
Toothpastes	Example/Comparative Example	Example 7	Example 8	Example 9	Example 10	Example 11	Example 12	
	Dentinal tubule occlusion rate (%)	40.5	59.9	51.3	55.1	46.4	65.1	
Toothpastes	Example/Comparative Example	Example 13	Example 14	Example 15	Example 16	Example 17	Example 18	
	Dentinal tubule occlusion rate (%)	51.9	71	65.1	67.8	56.3	75.2	
Toothpastes	Example/Comparative Example	Example 19	Example 20	Example 21	Example 22	Example 23	Example 24	
	Dentinal tubule occlusion rate (%)	63.6	83	70.6	85.7	69.2	87.7	
Toothpastes	Example/Comparative Example	Example 25	Example 26	Example 27	Example 28	Example 29	Example 30	
	Dentinal tubule occlusion rate (%)	90.6	100	100	100	95.8	100	
Toothpastes	Example/Comparative Example	Comp. Ex. 1	Comp. Ex. 2	Comp. Ex. 3	Comp. Ex. 4	Comp. Ex. 5	Comp. Ex. 6	Comp. Ex. 7
	Dentinal tubule occlusion rate (%)	51.4	0	6.4	12.6	18.1	25.6	42.3
Toothpastes	Example/Comparative Example	Comp. Ex. 8	Comp. Ex. 9	Comp. Ex. 10	Comp. Ex. 11			
	Dentinal tubule occlusion rate (%)	0	0	0	0			
Toothpastes	Example/Comparative Example	Comp. Ex. 12	Comp. Ex. 13	Comp. Ex. 14	Comp. Ex. 15	Comp. Ex. 16	Comp. Ex. 17	
	Dentinal tubule occlusion rate (%)	3.5	6.5	10.7	14	19.3	22.1	
Toothpastes	Example/Comparative Example	Comp. Ex. 18	Comp. Ex. 19	Comp. Ex. 20	Comp. Ex. 21	Comp. Ex. 22	Comp. Ex. 23	
	Dentinal tubule occlusion rate (%)	9.3	6.4	3.1	28.7	6.4	21.9	

TABLE 28-continued

Toothpastes	Example/Comparative Example	Comp. Ex. 24	Comp. Ex. 25	Comp. Ex. 26	Comp. Ex. 27	Comp. Ex. 28	Comp. Ex. 29	
	Dentinal tubule occlusion rate (%)	23.9	12.8	10.8	34.6	12.2	22.5	
Toothpastes	Example/Comparative Example	Comp. Ex. 30	Comp. Ex. 31	Comp. Ex. 32	Comp. Ex. 33	Comp. Ex. 34	Comp. Ex. 35	
	Dentinal tubule occlusion rate (%)	32.6	18.2	14.4	21.9	18.7	3.2	
Toothpastes	Example/Comparative Example	Comp. Ex. 36	Comp. Ex. 37	Comp. Ex. 38	Comp. Ex. 39	Comp. Ex. 40	Comp. Ex. 41	
	Dentinal tubule occlusion rate (%)	45.7	25.8	19.2	32.4	25.5	6.8	
Toothpastes	Example/Comparative Example	Comp. Ex. 42	Comp. Ex. 43	Comp. Ex. 44	Comp. Ex. 45	Comp. Ex. 46		
	Dentinal tubule occlusion rate (%)	64.6	42	53.4	42.6	10.1		
Mouthwashes	Example/Comparative Example	Example 31	Example 32	Example 33	Comp. Ex. 47	Comp. Ex. 48	Comp. Ex. 49	
	Dentinal tubule occlusion rate (%)	30.4	33.3	35.3	6.5	0	3.3	
Mouthwashes	Example/Comparative Example	Comp. Ex. 50	Comp. Ex. 51	Comp. Ex. 52	Comp. Ex. 53	Comp. Ex. 54	Comp. Ex. 55	Comp. Ex. 56
	Dentinal tubule occlusion rate (%)	6.6	7.1	6.9	10.6	3.8	3	3.9
Dentinal tubule-occluding agents	Example/Comparative Example	Example 34	Example 35	Example 36	Example 37	Example 38	Example 39	
	Dentinal tubule occlusion rate (%)	46.5	56.3	66	63.7	69.9	74.8	
Dentinal tubule-occluding agents	Example/Comparative Example	Example 40	Example 41	Example 42	Example 43	Example 44		
	Dentinal tubule occlusion rate (%)	75	82.3	87.5	89.9	90		
Dentinal tubule-occluding agents	Example/Comparative Example	Example 45	Example 46	Example 47	Example 48	Example 49		
	Dentinal tubule occlusion rate (%)	95.6	93.2	91.2	84.1	100		
Dentinal tubule-occluding agents	Example/Comparative Example	Comp. Ex. 57	Comp. Ex. 58	Comp. Ex. 59	Comp. Ex. 60			
	Dentinal tubule occlusion rate (%)	14.3	19.2	26	43.7			
Dentinal tubule-occluding agents	Example/Comparative Example	Comp. Ex. 61	Comp. Ex. 62	Comp. Ex. 63	Comp. Ex. 64			
	Dentinal tubule occlusion rate (%)	0	0	0	0			
Dentinal tubule-occluding agents	Example/Comparative Example	Comp. Ex. 65	Comp. Ex. 66	Comp. Ex. 67	Comp. Ex. 68	Comp. Ex. 69	Comp. Ex. 70	Comp. Ex. 71
	Dentinal tubule occlusion rate (%)	4.5	7.8	11.5	15.1	18.7	20.1	23.2
Dentinal tubule-occluding agents	Example/Comparative Example	Comp. Ex. 72	Comp. Ex. 73	Comp. Ex. 74				
	Dentinal tubule occlusion rate (%)	14.6	20.5	7.6				
Dentinal tubule-occluding agents	Example/Comparative Example	Comp. Ex. 75	Comp. Ex. 76	Comp. Ex. 77	Comp. Ex. 78	Comp. Ex. 79	Comp. Ex. 80	
	Dentinal tubule occlusion rate (%)	19.4	37.5	18.7	18.7	39.5	20.8	
Dentinal tubule-occluding agents	Example/Comparative Example	Comp. Ex. 81	Comp. Ex. 82	Comp. Ex. 83				
	Dentinal tubule occlusion rate (%)	27.3	49.4	23.6				
Dentinal tubule-occluding agents	Example/Comparative Example	Comp. Ex. 84	Comp. Ex. 85	Comp. Ex. 86	Comp. Ex. 87	Comp. Ex. 88	Comp. Ex. 89	
	Dentinal tubule occlusion rate (%)	35.4	54.2	21.4	49.9	34.2	14.9	
Dentinal tubule-occluding agents	Example/Comparative Example	Comp. Ex. 90	Comp. Ex. 91	Comp. Ex. 92	Comp. Ex. 93	Comp. Ex. 94	Comp. Ex. 95	
	Dentinal tubule occlusion rate (%)	34.9	46	11.8	38.2	35.9	3.4	
Dentinal tubule-occluding agents	Example/Comparative Example	Comp. Ex. 96	Comp. Ex. 97	Comp. Ex. 98				
	Dentinal tubule occlusion rate (%)	63.6	42.7	20.1				

As demonstrated in Comparative Examples 3 to 7 and 12 to 17, etc., hydroxyapatite and calcium monohydrogen phosphate dihydrate each singly had an ability to occlude dentinal tubules of a tooth. As the amount blended increased, the occlusion rate became higher. By contrast, as shown in Comparative Examples 8 to 11, potassium nitrate alone has no ability to occlude dentinal tubules of a tooth.

In addition, Comparative Example 3 was compared with Comparative Examples 19 and 22; Comparative Example 4 was compared with Comparative Examples 25 and 28;

Comparative Example 5 was compared with Comparative Examples 31 and 34; Comparative Example 6 was compared with Comparative Examples 37 and 40; and Comparative Example 7 was compared with Comparative Examples 43 and 45. These comparisons clearly demonstrate that blending potassium nitrate in hydroxyapatite did not change the occlusion rates compared with those when hydroxyapatite alone was used. Hence, no increase in the occlusion was observed. Likewise, Comparative Example 12 was compared with Comparative Example 20; Comparative Example 13 was compared with Comparative Example 41; Comparative Example 14 was compared with Comparative Example 26; Comparative Example 15 was compared with Comparative Example 32; Comparative Example 16 was compared with Comparative Example 38; and Comparative Example 17 was compared with Comparative Examples 23. These comparisons clearly demonstrate that blending potassium nitrate in calcium monohydrogen phosphate dihydrate did not change the occlusion rates compared with those when calcium monohydrogen phosphate dihydrate alone was used. Hence, no increase in the occlusion was observed.

Further, Comparative Example 18 was compared with Comparative Examples 3 and 12; Comparative Example 21 was compared with Comparative Examples 3 and 17; Comparative Example 24 was compared with Comparative Examples 4 and 14; Comparative Example 27 was compared with Comparative Examples 4 and 17; Comparative Example 30 was compared with Comparative Examples 5 and 15; Comparative Example 33 was compared with Comparative Examples 5 and 12; Comparative Example 36 was compared with Comparative Examples 6 and 16; Comparative Example 39 was compared with Comparative Examples 6 and 13; Comparative Example 42 was compared with Comparative Examples 7 and 17; and Comparative Example 44 was compared with Comparative Examples 7 and 14. These comparisons clearly demonstrate that the occlusion rate when both two components of hydroxyapatite and calcium monohydrogen phosphate dihydrate were blended was substantially the same as a total of the occlusion rates when hydroxyapatite and calcium monohydrogen phosphate dihydrate each singly were blended. Hence, a combination of these components does not cause a synergistic occlusion-promoting effect.

By contrast, use of an oral composition containing three components of hydroxyapatite, potassium nitrate, and calcium monohydrogen phosphate dihydrate according to the present invention resulted in the effect of synergistically increasing an occlusion rate.

Specifically, for example, Example 1 (occlusion rate: 29.6%) or Example 5 (occlusion rate: 34.5%) was compared with Comparative Example 18 (occlusion rate: 9.3%); Example 2 (occlusion rate: 49.0%) or Example 6 (occlusion rate: 53.7%) was compared with Comparative Example 21 (occlusion rate: 28.7%); Example 9 (occlusion rate: 51.3%) was compared with Comparative Example 24 (occlusion rate: 23.9%); Example 8 (occlusion rate: 59.9%) or Example 12 (occlusion rate: 65.1%) was compared with Comparative Example 27 (occlusion rate: 34.6%); Example 13 (occlusion rate: 51.9%) or Example 17 (occlusion rate: 56.3%) was compared with Comparative Example 33 (occlusion rate: 21.9%); Example 21 (occlusion rate: 70.6%) was compared with Comparative Example 39 (occlusion rate: 32.4%); Example 22 (occlusion rate: 85.7%) was compared with Comparative Example 36 (occlusion rate: 45.7%); Example 28 (occlusion rate: 100%) was compared with Comparative Example 44 (occlusion rate: 53.4%); and Example 26 (occlusion rate: 100%) or Example 30 (occlusion rate: 100%) was compared with Comparative Example 42 (occlusion rate: 64.6%). These comparisons clearly demonstrate a synergistic effect obtained by using a combination of the three components.

INDUSTRIAL APPLICABILITY

An oral composition according to the present invention has a quite excellent inhibitory hypersensitivity and its industrial usefulness is high.

The invention claimed is:

1. A method for suppressing hypersensitivity, comprising contacting an oral composition comprising 0.5 to 20% by weight of hydroxyapatite having an average particle size of 0.01 to 10 μm, 2.5 to 10% by weight of potassium nitrate, and 0.5 to 25% by weight of calcium monohydrogen phosphate dihydrate to dentin of a tooth in an oral cavity of a subject in need of increasing an ability to occlude dentinal tubules of a tooth.

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